*Workshop Report*

# NSF Professional Development Workshop in Ceramics

*NSF Grant DMR 1048443*

*Workshop Organizer*

**William G. Fahrenholtz**

*Workshop Location and Dates*

**Westin Arlington Gateway**
**Arlington, VA 22203**
**May 23-24, 2011**

# Executive Summary

The NSF Professional Development Workshop in Ceramics was held May 23 and 24, 2011 in Arlington, VA. The workshop focused on enhancing the professional development of early career faculty, in particular three recent CAREER awardees in the ceramics program in the Division of Materials Research (DMR) in the Directorate for Mathematical and Physical Sciences. These three faculty were Erica Corral, an assistant professor of Materials Science and Engineering at University of Arizona; Javier Garay, an associate professor of Mechanical Engineering at University of California, Riverside; and Shriram Ramanathan, an associate professor of Engineering Sciences at Harvard University.

The NSF Faculty Early Career Development Program, better known as the CAREER program, is the agency's second most prestigious award for early-career faculty (after the Presidential Early Career Award for Scientists and Engineers or PECASE). The program is designated for untenured assistant professors who are beginning independent research careers. Proposals are expected to contain sections devoted to research, teaching, and the integration of research into education. Applicants are encouraged to have assessment plans for both the research and education efforts to determine if the goals described in the proposal are met. Finally, CAREER proposals may also include an international component, if the activities and benefits of the international interaction are clearly defined. By the conclusion of a five year CAREER project, faculty are expected to be on a path that will help them become recognized leaders in their fields.

One overarching goal of the workshop was to enhance the professional development of three recent CAREER award winners with research projects in ceramics. This objective was accomplished by organizing two days of activities that included critical evaluation of the proposed activities of the three CAREER award winners, opportunities for networking among the participants, and presentations from NSF Program Directors about complementary areas where faculty might find additional opportunities for individual or collaborative projects. In addition to the three CAREER award winners, workshop participants included leading researchers from the fields of the three CAREER award winners, other senior scientists in ceramics, several early-career faculty, and Program Directors from NSF. Part of the schedule was built around sessions focused on the CAREER award winners, and an emphasis was placed on time for formal discussions, questions and answers with the NSF Program Directors, and informal networking among all of the participants.

Pre- and post-workshop surveys were used to identify factors thought to affect the professional development of early-career faculty. Publishing papers in peer-reviewed journals was rated the most beneficial for professional development. Other factors with strong, positive impacts on professional development were reputation of the present institution, networking at technical meetings, and mentoring by campus and/or professional colleagues. Having a large campus service burden, building a web presence, and teaching too many different/new classes were identified by participants as factors thought to have little or no impact on professional development. Taken as a whole, the survey results and comments from participants indicate that early-career faculty have a number of possible paths to success. Minimizing time spent on activities that have no impact on professional development may be as important to success as publications, networking and mentoring.

# Acknowledgements

The workshop activities were sponsored by the National Science Foundation through grant DMR 1048443. The opinions, findings, conclusions, and recommendations expressed in this report are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

I am grateful to Dr. Lynnette Madsen, Program Director for Ceramics in DMR for her support and guidance through the course of the effort. In addition, I would like to thank all of the participants in the workshop. It would not have been a success without their efforts. In particular, the expert panelists took time to read the proposals from the CAREER awardees and to travel from as far away as Italy and Japan to participate in the workshop. In addition, the questions raised by the early-career faculty participating in the workshop led to some great discussions in which all of us learned about a variety of topics including expectations for junior faculty and NSF program areas. Finally, I would like to thank Ms. Amy Moore for her role in the workshop. Among the many things that she did, Amy coordinated the travel arrangements for the participants, handled the reception area, and led the negotiations with the hotel for our hotel rooms, workshop space and food. Needless to say, the workshop would not have been the same without her tremendous effort.

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# 1. Objective and Focus of Workshop

The objective of the NSF Professional Development Workshop in Ceramics was to enhance the career development of early-career faculty with research expertise in ceramic materials. The workshop activities centered on the professional development of three faculty who were awarded NSF CAREER projects through the Ceramics Program in the Division of Materials Research (DMR) in 2009. In addition, three leading professionals were invited to evaluate the research activities of each CAREER awardee.

Faculty were targeted as the focus of this workshop based on two criteria: 1) a recent successful NSF CAREER proposal; and 2) research related to ceramic materials. Three faculty who met these criteria were Erica Corral from University of Arizona, Shriram Ramanathan from Harvard University, and Javier Garay from University of California, Riverside. The rest of this section provides brief biographical information about each of these participants.

Dr. Erica Corral is an assistant professor in the Department of Materials Science and Engineering at the University of Arizona. Erica holds a Ph.D. from Rice University. She also completed a post-doctoral fellowship at Sandia National Laboratories prior to joining the faculty at Arizona. Erica's research areas include ultra-high temperature ceramics, glass-to-metal sealing, and carbon nanotubes. Specifically for the CAREER program, Erica is investigating oxidation mechanisms in multilayered structures. Erica has published nearly 20 papers to date in her professional career.

Dr. Shriram Ramanathan is an associate professor of Engineering Sciences at Harvard University. Shriram received his Ph.D. from Stanford University. Shriram's research expertise is in micro fuel cells, ionic/electronic conductive ceramics, and photon/electron field effects. The research described in his CAREER grant focuses on structure-property relations in thin ceramic films as well as photon effects. Shriram has published nearly 90 papers to date in his professional career.

Dr. Javier Garay is an associate professor of Mechanical Engineering at University of California, Riverside. Javier received a Ph.D. from University of California, Davis. His research expertise lies in nanocomposites, field activated densification, and characterization of ceramic materials. For his CAREER grant, Javier is examining nanocomposites for optoelectronic applications with an emphasis on controlling the heterostructures through the use of external electric fields. Javier has published more than 40 papers to date.

# 2. Workshop Activities and Schedule

The workshop activities aimed at career development were: 1) a critical evaluation of the research plan for each of the targeted faculty including potential difficulties that might be encountered; 2) formal and informal interactions among the participants; and 3) a tour of facilities National Institute of Standards and Technology (NIST) pertinent to ceramics research to learn about resources available through collaboration (at no cost to academic researchers). In

addition, workshop participants were selected to provide a diverse group of professionals who had a broad array of perspectives on research and professional development activities. Finally, Directors from several NSF units, namely the Directorate for Mathematics and Physical Sciences (MPS), Office of International Science and Engineering (OISE), Directorate for Education and Human Resources (EHR), and the Directorate for Engineering (ENG), informed participants about other research opportunities. The full schedule for the workshop is provided in Table 1. The sub-sections that follow describe the main aspects of the workshop in more detail.

***Workshop Organization***

The workshop included three main sessions. For each session, one of the CAREER awardees presented a short (15 min or less) overview of the main goals of his/her project along with a summary of the main accomplishments to date. Next, three research experts from the specialty area of the CAREER awardee provided brief (5 min or less) comments on the proposed research and accomplishments. The remainder of the session (~90 min) was left for an interactive discussion that included the CAREER awardee, the expert panelists, and the other workshop participants.

***Participant Interactions***

The workshop was structured to facilitate both formal and informal interactions among the participants. Each of the main sessions included ample time for formal discussion of professional development activities among the participants. The audience was encouraged to ask questions of the CAREER winner, the expert panelists, or other members of the audience. In addition, the schedule included unstructured time for informal interactions. Participants were encouraged to interact during morning and afternoon breaks, and meals, all of which were provided at the meeting site.

***NIST Tour***

The workshop activities included a tour of the National Institute of Science and Technology in Gaithersburg, MD. The tour was organized to inform workshop participants about the facilities available to all researchers through NIST as well as joint NSF-NIST opportunities.

***Diverse Participation***

The workshop participants were selected to provide a broad variety of experience levels and backgrounds. In addition to the three CAREER award winners, eight expert panelists, two senior scientists, and six early-career faculty participated in the workshop. The early-career faculty included several faculty who were in their first year or two of tenure-track appointments and one post-doctoral scholar hoping to find a tenure-track position in the near future. The expert panelists had established reputations in their respective fields and were selected based on recommendations from the CAREER winners for leaders in each of their fields. Finally, two participants were from outside the U.S. to provide a global perspective in the discussions.

***NSF Information***

Presentations were solicited from other program areas within NSF in an effort to broaden knowledge of the agency among the participants. Program Directors from OISE, EHR, and ENG were invited in addition to participants from DMR and MPS. Each of the presentations was followed by a question and answer period so that participants could learn more about other

program areas within NSF that fund activities that complement the area in which the CAREER awards were made.

**Table 1. Schedule the NSF Professional Development Workshop in Ceramics.**

## Monday, May 23, 2011

| Time | Activity | Description |
|---|---|---|
| 8:00 am | Registration and morning coffee/tea | Informal discussions and networking |
| 9:00 am | Welcome and Introductions | Bill Fahrenholtz, Missouri S&T;<br>Ed Seidel, Assistant Director of Mathematical & Physics Sciences (MPS) at NSF;<br>Ian Robertson, Division Director, Division of Materials Research (DMR) at NSF and<br>Lynnette Madsen, Program Director, Ceramics, DMR, NSF |
| 9:15 am | DMR Overview | Ian Robertson |
| 9:45 am | Morning Break | Refreshments, discussions and networking |
| 10:15 am | Session 1 | Erica Corral, Univ. of Arizona: Oxidation Mechanisms<br>Panelists: Greg Hilmas, Missouri S&T; Beth Dickey, NC State; and Laura Silvestroni, Inst. For Science and Technology of Ceramics, Faenza Italy |
| 12:15 pm | Catered Lunch | On-site lunch: discussions and networking |
| 1:30 pm | Overview of International Programs | Lynnette Madsen, DMR and Jennifer Pearl, OISE |
| 2:00 pm | Session II | Javier Garay, UC-Riverside: Optoelectronic Nanocomposites<br>Panelist: T. Goto, Tohuko U., Japan; W. Soboyejo, Princeton; Eric Fullerton, UCSD |
| 4:00 pm | Afternoon Break | Refreshments, discussions and networking |
| 4:30 pm | Opportunities in the Directorate for Engineering (ENG) | Clark Cooper<br>Program Director in ENG at NSF |
| 5:30 pm | Role of Technical Societies in Professional Development | Marina Pascucci, CeraNova, Inc., President of the American Ceramic Society |
| 6:15 pm | Dinner | On-site dinner: informal discussions and networking |

## Tuesday, May 24, 2011

| Time | Activity | Description |
|---|---|---|
| 8:00 am | Coffee and Tea | Informal discussions and networking |
| 8:30 am | Faculty Entrepreneurship | Angus Kingon, Brown University |
| 9:00 am | Education and Human Resources (EHR), Overview of ADVANCE | Amy Rogers Program Director in EHR at NSF |
| 9:30 am | Morning Break | Refreshments, discussions and networking |
| 10:00 am | Session III | Shriram Ramanathan, Harvard: Functional Thin Films<br>Panelists: Yet-Ming Chiang, MIT, Andrew Rappe, U. Penn, |
| Noon | Wrap-up Discussion | Concluding thoughts and input for report |
| 12:30 pm | Catered Lunch | On-site lunch: discussion and networking |
| 2:00 pm | Optional NIST Tour | Tour of NIST, hosted by Martin Green |

# 3. Pre-Workshop Survey

Prior to the workshop, participants were given a brief survey (Table 2). The results were analyzed to identify the factors that the participants deemed most important to the professional development of early-career faculty. The scale used on the survey was selected to identify factors that were likely to have a strong positive impact on professional development (rated 3), no impact on professional development (rated 0), or a negative impact on professional development (rated -3). Based on the averages compiled in Figure 1, analysis of the results revealed that the activities could be divided into three groups:

1. A strong positive impact with an average rating above 2.0 (red band on Figure 1)
   - Networking at technical meetings (Question 3)
   - Publishing in peer-reviewed journals (Question 4)
   - Mentoring by a department, campus, or professional colleague (Question 7)
   - Stature of funding agencies (Question 10)
2. A positive impact with a rating between 1.0 and 2.0 (yellow band on Figure 1)
   - Pedigree: Reputation of Ph.D. advisor and/or graduate institution (Question 1)
   - Reputation of current institution (Question 2)
   - Professional service activities (Question 6)
3. No impact on professional development with a rating of less than 1.0
   - Web presence (Question 5)
   - Institutional service (Question 8)
   - Publicity in technical media (Question 9)

Interestingly, none of the suggested activities were judged to have a negative impact on professional development. This result suggests that almost any activity has a positive impact on professional development. Given that faculty have a limited probationary period before a tenure decision is made, the lower ratings of some of the activities could be taken as an indication that spending time on them might take away from other, more important activities.

**Table 2. Pre-workshop survey**

Rate each the factors with respect to their impact on the professional development of early-career faculty.

The rating scale is -3 -2 -1 0 1 2 3

strong negative none strong positive

1. Pedigree or the reputation of Ph.D. advisor and/or graduate institution
   a. -3 -2 -1 0 1 2 3
2. Reputation of present institution or department
   a. -3 -2 -1 0 1 2 3
3. Networking at technical meetings
   a. -3 -2 -1 0 1 2 3
4. Publishing in peer-reviewed journals
   a. -3 -2 -1 0 1 2 3
5. Web presence including conventional webpage, Facebook, Twitter, etc.
   a. -3 -2 -1 0 1 2 3
6. Professional service activities such as symposium organization, reviewer, society officer, etc.
   a. -3 -2 -1 0 1 2 3
7. Mentoring by a department, campus, or professional colleague
   a. -3 -2 -1 0 1 2 3
8. Institutional service such as campus committees, recruiting activities, or student group advisor
   a. -3 -2 -1 0 1 2 3
9. Publicity in non-technical media such as press releases, web highlights, or trade journal articles
   a. -3 -2 -1 0 1 2 3
10. Agencies that fund research or specific programs (e.g., CAREER or PECASE)
    a. -3 -2 -1 0 1 2 3

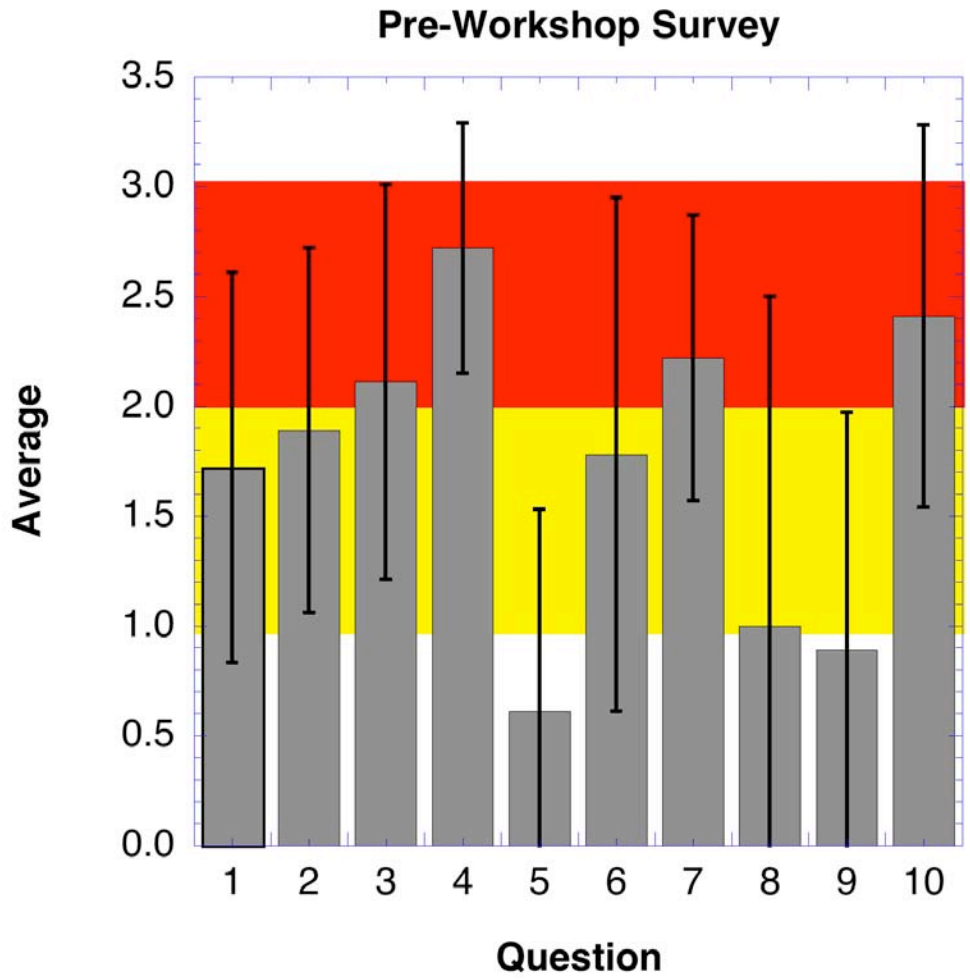


**Figure 1. Summary of results of the Pre-Workshop Survey questions listed in Table 2.**

In addition to the numeric results, workshop participants were also given the chance to comment on other factors that they deemed important in professional development. Some of other factors that were identified as having a positive influence on professional development were:

- Visiting funding agency program officers regularly
- Participating in program reviews
- Giving invited presentations at conferences
- Publishing in high impact journals
- Being nominated for campus and professional awards
- Participating in grant writing workshops

Likewise some of the other factors that were identified as having a negative influence on professional development were:

- Having high teaching and/or service loads
- Focusing on "letter-type" publications
- Collaborating with senior faculty who have similar expertise
- Teaching too many different classes
- Trying to do too much
- Ignoring weaknesses or not addressing them

From the results of the survey, the most important factor contributing to professional development of early-career faculty was publishing in peer-reviewed journals, which was closely followed by mentoring and the stature of the funding agencies that support grants of the faculty member. Similarly, the comments were focused on activities such as participating in program reviews and giving presentations at technical conferences. The survey also revealed that institutional service and other activities that did not involve building a strong research reputation had no impact on professional development. Likewise, the comments on negative impacts were focused on activities that took time away from more beneficial activities. One conclusion that can be drawn from the results is professional development is enhanced by activities that increase the visibility of the faculty member among others in his/her research area. However, the spirit of the survey and the comments indicate that professional development requires a breadth of activities that go beyond simply maximizing research productivity.

# 4. Summary of Workshop Activities

The formal workshop activities began with a welcome by Dr. Ed Seidel, Associate Director for MPS at NSF. Dr. Seidel stressed the importance of the CAREER program to the foundation. He also took the initiative to have each of the participants introduce themselves. Next, Dr. Ian Roberston, the Director for the Division of Materials Research gave an overview of DMR activities. Some of the information that he passed along was that DMR was the largest division in MPS and that division grants supported about 2800 graduate students and 700 post-doctoral scholars. He went on to describe some of the research infrastructure supported by DMR such as the synchrotron facility at Cornell as well as the user facilities supported through the Materials Research Science and Engineering Centers (MRSECs). Dr. Roberston provided statistics about the funding rates for proposals within the directorate with breakdowns for CAREER proposals, unsolicited grants, and renewals. He also mentioned that the NSF budget request for FY 2012 is available on line (http://www.nsf.gov/about/budget/fy2012/).

After a break, the first evaluation session of the workshop began. This session was focused on Dr. Erica Corral. The three expert panelists who were asked to evaluate her proposal and recent accomplishments were Professor Beth Dickey from North Carolina State University, Professor Greg Hilmas from Missouri University of Science and Technology, and Dr. Laura Silvestroni from the Institute for Science and Technology of Ceramics in Faenza, Italy. Erica began with an overview of her proposed research followed by a summary of her accomplishments. Her presentation ended with a description of the outreach activities that she has initiated at Arizona. Next, the expert panelists made brief remarks about their assessment of the strengths and weaknesses of her proposed effort. Some of the strengths of her effort were that she had put together a hypothesis-driven research plan and that she had a very impressive education/outreach plan. The panelists expressed concerns that the initial research plan did not contain enough technical details, that some of the structures proposed may be difficult to produce due to residual stresses, and that she may be trying to do too many things. The session ended with an interactive discussion with participation from Erica, the expert panelists, and the audience. One of the key points made during the discussion were that NSF proposals were not iron-clad contracts, but were grants – a starting point for exploration that could be adjusted along the way. In addition,

the important issue of how to attribute results from within a research group that is supported by similar proposals to different agencies was discussed.

The next session was a discussion of NSF international opportunities in the Office of International Science and Engineering (OISE) and within DMR. The OISE portion was led by Jennifer Pearl, while Lynnette Madsen addressed the DMR avenues (supplements, Materials World Network and International Materials Institutes). Jennifer began with an overview of the funding mechanisms within OISE, including an upcoming solicitation for Partnerships in International Research and Education (PIRE) that will be issued soon. She also discussed efforts to balance the portfolio at the level of the individual program director and division levels. The session included time for discussion with the participants who had both specific questions about certain opportunities as well as more general questions about expectations of Program Directors and interpretation of reviews.

The session evaluating the proposal and accomplishments of Javier Garay followed the OISE overview. Javier provided an overview of his proposal, his accomplishments to date, his synergistic activities, and his outreach/education activities. Following his presentation, the three expert panelists commented on his plans and accomplishments. The expert panelists were Professor Eric Fullerton from University of California, San Diego; Professor Takashi Goto from Tohuko University in Japan; and Professor Wole Soboyejo from Princeton University. Among the strengths that were noted, Javier was commended for his incorporation of preliminary results into his proposal, the use of physics-based models to guide his work, and his interactions with students. Some of the opportunities for improvement that were noted included providing more details of how optoelectronic performance could be optimized, addressing the need to understand some of the fundamental processing effects, and becoming more visible outside of his institution. The discussion that followed included topics such as methodology for education-based research, the utility of physics-based models for fundamental understanding, and the complexity of grain boundaries in multi-phase systems.

Clark Cooper, Director of the Materials and Surface Engineering (MSE) program in the Engineering directorate, was the next speaker. Clark focused on activities in the MSE program. He provided examples of project topics, a description of how the MSE program differs from programs in DMR, and a summary of funding rates for unsolicited proposals as well as CAREER projects. Clark emphasized that programs in MSE ranged from theoretical to experimental with a preference for hypothesis-driven investigations. The funding rate has been ~12% and all proposals are reviewed by panels. Information was also provided on the Emerging Frontiers of Research and Investigation (EFRI) program, which funds research on topics selected by the Program Director. As with the other sessions, this session included a vibrant discussion with a variety of specific and general questions related to preparing proposals, preferred topics, portfolio balance, and interpretation of reviews.

The final session of the first day began with a presentation by Marina Pascucci who is the current president of the American Ceramic Society (ACerS). Her presentation focused on opportunities within professional societies for involvement. She reiterated a point made earlier that networking was a strong component of professional development and went on to emphasize that networking was still largely a face-to-face activity. The discussion that followed included topics

such as specific opportunities within ACerS and other technical societies such as leadership positions, journal reviewers, and programming, as well as more general questions about how to make contact and the best way to get started with a technical society.

The second day of the workshop began with a presentation by Professor Angus Kingon on faculty entrepreneurship. Angus conveyed his passion for entrepreneurship and described case studies of success including A123 Systems, which was founded by another workshop participant Professor Yet-Ming Chiang. Angus provided statistics on the number of new businesses created each year in the U.S., the average size of these businesses, and the average lifetime of the ventures. His presentation emphasized the need for both quantity and quality of science prior to starting a business along with the steps required to take an idea from the laboratory to a company that has the potential for success. The discussion included differentiating characteristics between faculty entrepreneurship and licensing of technology.

Amy Rogers from the EHR Directorate provided an overview of the ADVANCE program, which promotes increased participation of women in academic science and engineering careers. She described the three tracks of the ADVANCE program, which are: 1) institutional transformation (IT), 2) IT catalyst projects (aimed at smaller campuses); and 3) partnerships for adaptation, implementation, and dissemination (PAID). The resulting discussion covered a wide variety of issues including historic trends for participation of women and systemic factors that can be changed to make academic careers more attractive to women.

The third evaluation session focused on Shriram Ramanathan. Shriram began with an overview of the goals of his proposal and then gave a detailed description of the results of his group. The expert panelists for his session were Professor Andrew Rappe from University of Pennsylvania and Professor Yet-Ming Chiang from the Massachusetts Institute of Technology. Some of the positive aspects of Shriram's work that were noted were the benefit of his industrial experience, the bold nature of his proposed research, and the novel aspect of the photo-assisted growth method that he described. Some areas noted for possible improvement were the need to investigate lower-cost, scalable processing methods, improvement of his ability to communicate impact of results to non-experts, and perhaps a need to increase the synthesis effort by exploring molecular beam epitaxy (MBE) type techniques. The discussion that followed had a different focus than the previous two evaluation sessions. The general discussion covered topics such as the positive and negative aspects of research centers, the use of Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs to fund university research, and the value of industry experience. A long discussion of the need to pursue collaborative efforts to build a focused research laboratory also ensued among the panelists and attendees.

The formal workshop sessions concluded with a wrap-up session. This session was led by Lynnette Madsen, director of the Ceramics program in DMR. Lynnette probed the audience with a series of questions to gauge their perception of the workshop. Some of the questions that were discussed were whether a workshop like this should be organized again and could the panel experts do more. The discussion that followed showed overwhelming support for having another event like this workshop. The participants noted that the depth of the information provided about the NSF programs was a very important aspect of the workshop. It was also noted that the

timing of the workshop (late May) was good relative to the deadline for CAREER proposals (mid July). Among the participants, several mentioned that the workshop should include more junior faculty. Finally, the CAREER winners noted that a great deal of information was conveyed during the sessions and that it would be useful to have the other CAREER winners record the comments during the session.

An optional tour of the National Institute of Science and Technology was scheduled for the final afternoon of the workshop. The tour focused on the ceramic research facilities at NIST in Gaithersburg, MD. From the overall workshop attendees, 13 participated in the NIST tour (Table 3). Dr. Martin Green, a NIST scientist who supervises the Functional Properties Group at NIST, was the host. Upon our arrival, Dr. Green provided an overview presentation of the activities and organization of NIST. Dr. Green's presentation included information on NIST resources such as traceable standards as well as equipment and facilities that were available to academic researchers at no cost. Next, Dr. Joshua Martin described research related to the measurement of thermoelectric materials. The NIST activities concluded with a tour led by Dr. Robert Cook, who described the metrology laboratories where measurements were made in environments where the temperature, humidity, particulate content of the air, and other variables were precisely controlled.

**Table 3. List of participants in the NIST tour.**

| | | |
|---|---|---|
| Erica Corral | Javier Garay | Amy Moore |
| Shen Dillon | Takashi Goto | Marina Pascucci |
| Tabbetha Dobbins | Greg Hilmas | Laura Silvestroni |
| Rich Eitel | Lynnette Madsen | Grace Yong |
| Bill Fahrenholtz | | |

# 5. Post-Workshop Survey

At the conclusion of the workshop, the participants were given a survey with the same questions that were asked prior to the workshop. The results are shown in Figure 2. Some changes were noted between the pre- and post-workshop surveys. Question 4, publishing in peer reviewed journals, was still identified as the most important factor in professional development. Other factors with high importance were the reputation of the current institution (Question 2), networking at technical meetings (Question 3), and mentoring (Question 7). Compared to the pre-workshop survey, the reputation of the current institution (Question 2) moved onto the list of factors with high importance while the importance of funding (Question 10) moved down.

Factors that were deemed important in the post-workshop survey were pedigree (Question 1), professional service (Question 6) and importance of funding (Question 10). As discussed above, the rating of reputation of the current institution (Question 2) increased to move it into the "high importance" category, while the rating of importance of the funding (Question 10) decreased to add it to the "important" list. In addition, the rating of institutional service (Question 8) decreased and it moved to the "not important" list.

The factors that were not important were web presence (Question 5), institutional service (Question 8), and publicity (Question 9).

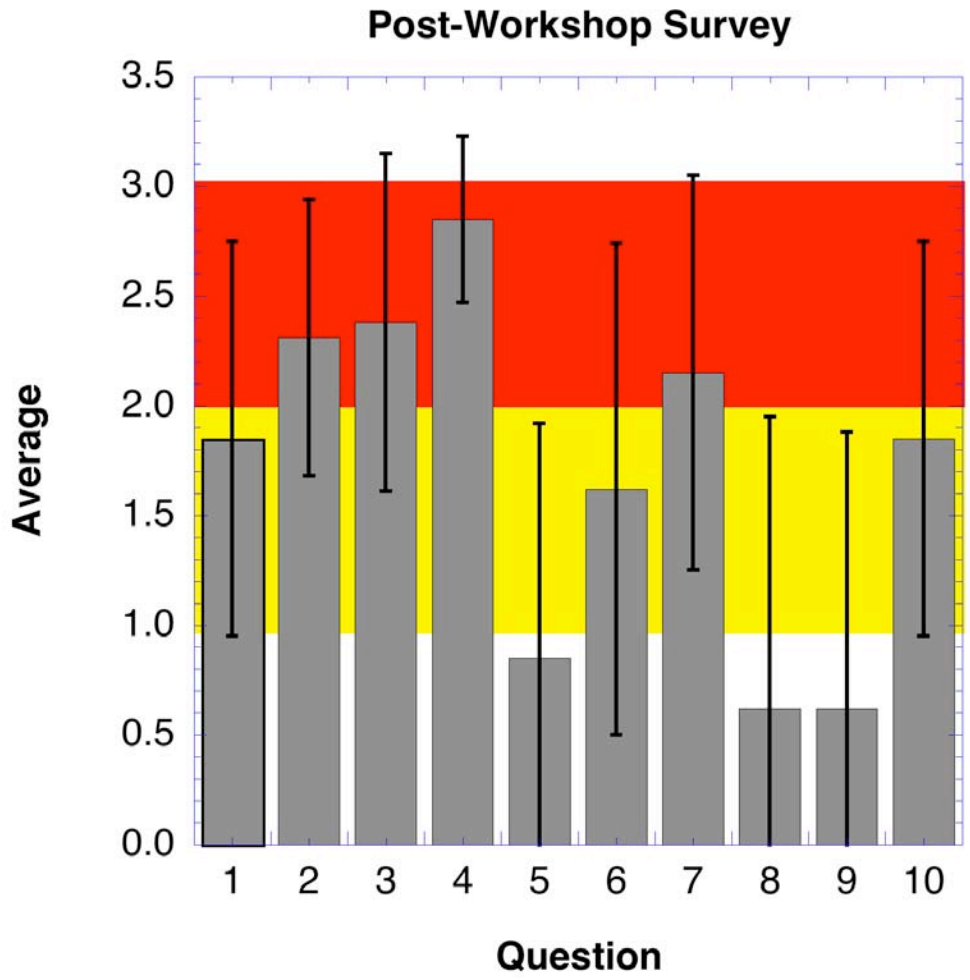


**Figure 2. Summary of results of the Post-Workshop Survey questions.**

In addition to the numbered questions, participants were also asked to comment on factors that would impact professional development. The first section asked participants to comment on the activity that they believe would have the highest positive impact on professional development. While not all participants provided a suggestion, some of the comments were:

- Winning a CAREER award
- Working with a quality mentor
- Networking with technical professionals
- Getting to know Program Officers, Directors and Managers at various (federal) funding agencies
- Performing high quality research and publishing the results

Other factors that were identified as having a positive impact on professional development were:

- Participating in professional development workshops
- Having colleagues critique proposals and papers
- Aligning outreach efforts with research and teaching activities
- Building a diverse funding portfolio
- Giving invited presentations and seminars
- Being actively involved in a professional society
- Working with a mentor
- Focusing on the quality of research and publications

Finally, factors that were mentioned as having a negative impact on professional development were:

- Over-reaching what can be done in research or outreach
- Having too much campus service
- Preparing too many new courses
- Publishing with a former advisor or other senior colleagues
- Teaching large classes

Considering the results of the post-workshop survey as a whole, publication in peer-reviewed journals is the most important factor in professional development for early-career faculty. As indicated by the workshop discussions and some of the written comments, publications require that the faculty establish a research area, mentor students to perform research, and produce advances that are sufficient to warrant publication. However, the relative importance placed on reputation of the present institution, networking at technical meetings, and mentoring programs indicate that faculty are more likely to have successful research projects if they work at a university with a strong reputation, network with professional colleagues, and have a strong mentor. Likewise, a heavy institutional service load may take time away from time that would be better spent preparing manuscripts, networking, or interacting with mentors. Overall, faculty who develop active research and outreach programs with support from their department and professional colleagues without substantial service loads or unrealistic teaching expectations would seem to have the best chance for professional success.

# 6. Conclusions and Recommendations

The first NSF Professional Development Workshop in Ceramics was held May 23-24, 2011 in Arlington, VA. Approximately 30 people participated in various aspects of the workshop. The workshop consisted of presentations followed by question and answer sessions with NSF staff, discussion sessions focused on three recent winners of NSF CAREER awards, and presentations on other aspects of faculty professional development. The activities were generally well received by the participants. In particular, the early-career faculty who participated in the workshop found the activities particularly beneficial. In addition to the scheduled sessions, the workshop included significant time for informal interactions with a continental breakfast each morning, 30 minute breaks in the morning and afternoon sessions, catered lunches each day, and a group dinner at the end of the first day. Overall, the workshop seemed to be an effective method for providing detailed advice on professional development directly to faculty who had

recently been awarded NSF CAREER grants. In addition, other early-career faculty found the discussion beneficial for their own development, especially those who were planning to submit their own CAREER proposals. Finally, the sessions with NSF staff were found to be valuable by all of the participants due to the detailed information provided in the presentations and the opportunity to ask specific questions during the discussion period.

The comments on the workshop and its benefits were overwhelmingly positive. Given the benefit to the early-career faculty, it seems likely that similar workshops will be organized in the future for Ceramics and perhaps in other fields. The bulleted items below are provided to help guide future efforts. The order is random and does not reflect any prioritization or ranking.

- This type of workshop would be beneficial for any researcher who is new to NSF funding, not just CAREER award winners. The three researchers who were the focus of this workshop were relatively well established, so choosing more junior researchers for the focus of future workshops could maximize the benefit of the experience.
- Two of the participants in this workshop came from outside North America. While their perspective was valuable on research, they did not necessarily have a clear picture of the expectations on junior faculty in the U.S. In the future, foreign participants should be selected very carefully since the travel time required for them is disproportionally high compared to the time that they are at the workshop.
- The most difficult task associated with organizing the workshop was identifying and inviting the expert panelists. Because my research expertise closely matched that of one of the three CAREER winners (Corral), I found that recruiting panelists for that area was much easier because I knew the high-profile researchers in that field. However, recruiting expert panelists was very difficult for the other areas because I didn't personally know researchers in those areas nor was I as familiar with the key technical issues for their fields. Identifying and recruiting lead panelists or co-PIs for each research area to help recruit expert panelists would have been a big help. One way for this to happen would be to have co-PIs on the proposal including those funded on similar topics in those research areas.
- The proximity to NSF headquarters was a big bonus as it facilitated the inclusion of Program Directors from NSF in the workshop activities. Since the participants identified information from the program directors as one of the primary benefits of the workshop, the ability to attract NSF program directors should be considered for future workshops. In addition, the sessions with the program directors need to allow time for discussions so that participants can get the information that they want.
- The schedule for this workshop did not include time for each participant to do a self-introduction. Future workshops should allow time for each participant to not only introduce themselves, but to briefly describe their research and teaching areas.
- The NIST tour was particularly valuable because few, if any of the participants were aware of the joint programs or the facility access available to researchers working in materials science. In the future, a tour may not be feasible, but some of the same goals could be accomplished by having a speaker from NIST scheduled in the workshop. For other research areas, organizers may want to consider replacing the NIST activity with

other federal agencies based on access to research equipment, availability of joint resources, or the ability to request joint funding.

- The presentations on faculty entrepreneurship and professional society activities were valuable additions to this workshop. Other topics that should be considered for future workshops include: 1) the scholarship of teaching; 2) effective teaching strategies; 3) intellectual property issues related to patenting or publishing new results; 4) the perspective of a university promotion and tenure committee; and 5) case studies from successful faculty.

# Appendix 1: Workshop Participants


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